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ABSTRACT

For many students the present remedial mathematics curriculum is a collection of loosely related, very difficult to understand topics, and many, in consequence, lack the motivation to persist in remedial math courses. Most alternative instructional methods used in these courses fail to convey a sense of the underlying purpose of mathematics and thus do not enhance student motivation. The literature shows that calculators, multi-media aids, math anxiety interventions, programmed learning techniques, and real-life applications approaches all have many advocates, but studies have failed to demonstrate that these techniques significantly increase learning. To achieve the sense of instructional purpose ignored by these methods, the remedial mathematics curriculum should center around mathematical themes. Rather than sequentially introducing students to whole numbers, fractions, and so on, a remedial arithmetic course, for example, might address the themes of math as a purposeful creation, as the search for and use of coherent generalizations, as a means of simplifying quantifiable phenomena to improve understanding, and as a powerful, but limited tool. These themes can give direction to overall course- and specific lesson-planning. For example, the study of base 10 structures and measurement systems can be related to the first theme of man and his purposes. In this way, the thematic approach establishes coherence among the topics addressed.
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Thematic Teaching In Remedial Mathematics

Speech Before The
National Conference

On

Remedial and Developmental
Mathematics In College:
Issues and Innovations

April 9, 1981

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From the point of view of the learner, much of our present remedial mathematics curriculum appears to be little more than a collection of loosely related topics. Despite the instructor's concern and the obvious organized nature of the content, only on occasion does one idea seem to have a great deal to do with any other. But surely this is not the mathematics that you and I know. Mathematics, at every level, is rich with interrelationships. Very few, if any, well versed in the subject would describe it as a collection of nearly disjoint ideas. Nevertheless, this is what many students of remediation believe.

Adult students in remedial mathematics courses are commonly dubious about their entire remedial mathematics venture. Some perceive it as a nearly pointless exercise having very little to do with their lives, or with the larger world outside of the classroom. In addition, to understate the obvious, a significant number find the elementary topics of remediation to be quite difficult; sometimes disasterously so. Despite these difficulties, as each semester begins, the classes are filled with students ready to struggle with remedial mathematics. However, as early as midterm, a sizable number have already left the course. This unfortunate, but not uncommon, situation is attributable to a variety of causes. Various familiar possibilities include that some found the course too difficult, some found it too easy, some became ill or had

other serious personal problems and some, a by no means insignificant portion of the whole, just stopped attending. It is especially with the last group in mind, let us call them the voluntary quitters, that we consider the following argument.

Axiom I: Most people who believe they are wasting their time will cease wasting it.

Theorem I: There exist a significant number of students who believe they are wasting their time in remedial mathematics classes.

Proof: Behold!

The unfortunate consequences of Theorem I are that many people remain ignorant of the most basic quantitative rudiments. Such a situation is an utter waste of human potential. All of us know that these students are profoundly incorrect in choosing to exclude mathematics, at any level, from their lives. But all of us hear the music and see the rich tapestry that is mathematics. These students know nothing of such matters. However, we emphasize that their actions are not irrational. Given what we have described as their perceived experience with remedial mathematics, they have made the reasonable choice to terminate what they see as an arbitrary and undesirable relationship. If such a discouraging situation is to be changed, then it is the contention here that we should begin to address the issue of purpose in our teaching of remedial mathematics.

Man is generally a purposeful creature. There are usually rather apparent assignable causes for his behaving in one manner or another. Therefore, when required to perform a task,

he usually concerns himself with the possible motives associated with that task. In a classroom, the reasonable and often repeated request from the students, at almost any level of study, is "Why do we have to do this?", or "What is this used for?", or some other equivalent form. These questions are fundamental probes for purpose. We want them to labor over some ideas that we deem important and they simply and intensely want to know why. It would seem that we should begin to direct our remedial mathematics curriculum toward a coherent answer to this question of fundamental purpose of the subject. Presently, to my knowledge, no one is suggesting that we reformulate our remedial programs in such a light. Later in this talk we shall try to more precisely clarify the meaning of such a proposal. Presently, however, let us briefly examine what some people are offering as "alternatives" for the remedial mathematics program. There is no shortage of proposals.

This section of my talk has been designed with an eye toward making new enemies and perhaps influencing people.

Calculators and Other Technology in Remedial Mathematics

The calculator, not unlike the pencil, is a tool designed for a job. Tools or devices as such, offer few clues regarding to what ends we should use them. Employing the calculator in remedial arithmetic does not give coherence to the subject. Its use simply requires that we teach one set of computational methods rather than another. Thus, the introduction of calculators will not give students a sense of the purpose of their mathematical course work. But might not the students simply

learn more arithmetic? In response to this question, let us look briefly at some of the literature.

According to the Journal For Research In Mathematics Education, Judith Hector of the University of Tennessee, in her 1979 dissertation study entitled, "The Effects of Calculator Versus Conventional Algorithms for Fractions on Community College Student Computation, Understanding and Attitude Scores", found the following result,

"No significant differences in fraction computation, understanding or attitudes were found between groups using a conventional algorithm set with or without¹ calculators, or a calculator-based algorithm set."

A second selection, again from the Journal For Research In Mathematics Education, is another 1979 dissertation study. In this paper, by Janice Koop of the University of Colorado, we find similar results. The study, entitled, "A Description of the Effects of the Use of Calculators in the Community College Arithmetic Class", concludes,

"No significant differences were found on problem solving or computation between calculator and non-calculator groups. However, young students using calculators had higher scores as did students over 29 not using calculators."²

At this point, rather than be misunderstood, let me state emphatically that the above argument is not one in opposition to the use of calculators in the classroom. The argument, simply stated, is that the use of the calculator in achieving meaningful remedial mathematical course work offers irrelevancy, perhaps a bit of diversion and apparently "no significant difference" as its educational effects.

Now let us extend the above argument to include more of the plethora of available educational hardware. These include multi-media devices, computer assisted instruction and a host of other technological instruments used in connection with today's "innovative" teaching. However modern, expensive and impressively technical these devices might be, they do not tell us to what ends they should be used. They are hopelessly ignorant of purpose.

In connection with such hardware, we cite one particularly revealing piece of research. While this study did not concern students in a remedial course, it seemed quite appropriate for this discussion. The paper in question reports the effects of using multi-media devices in teaching a college level descriptive geometry class. It would seem that media paraphernalia would be ideally suited for a course so involved with geometric configuration. Imagine all of these orthographic projections and three-dimensional oblique views appearing directly before the students' eyes! Nevertheless, Rankowski and Glaey report,

"No significant difference in achievement was found between groups taught by a multimedia or conventional approach."

Now a few final words on the subject of media and mathematics. The argument presented above is in direct opposition to the fashionable claims of media experts and enthusiasts who, like Marshall McLuhan, believe that "the medium is the message." In mathematics, rather than the medium it is the mathematical content that is the message. If you prefer, the message is the message. But we have yet to discuss what you, the teacher, see as the purpose of that message.

Math Anxiety

I am not a trained psychologist. However, in all honesty, I am anxious about the furor surrounding math anxiety "interventions." Undoubtedly, most mathematics educators would agree that a significant number of students have enormous problems in trying to learn mathematics. From such a generally accepted precept, however, can we conclude that treatments for math anxiety are in order? Perhaps a more appropriate question is, "What is math anxiety intervention?" In response, we quote Sheila Tobias, a leading math anxiety proponent, from her recent speech at the AMATYC convention in Washington, D.C., October, 1980. She said,

"There are presently more than 100 math anxiety programs nationwide, providing intervention services to students that would otherwise be unaided in facing math mental blocks...We don't, however, know exactly what these programs are doing to deal with this problem."

This description is to some, both discouraging, and more than a bit alarming. Built upon the generally accepted notion that students have substantial difficulties with mathematics, a large number of programs have been created and are doing something; that is, one thing or another, but we really don't know what. This unstable situation is no cause for celebration. It is a situation reminiscent of the uncoordinated, unsubstantiated, unresearched and, most especially, ill defined efforts that have occurred in the recent past, and been known by such names as, "new math" and "back to basics." The math anxiety effort, like these previous movements is somewhat characterized by its anarchism, but mostly marked by its lack

of definition. After speaking to many mathematics educators, we believe it is this lack of definition that lends the illusive, nebulous, almost mystical quality to these programs, and consequently makes it difficult to understand what math anxiety intervention is; let alone offer any criticism of it. It appears the math anxiety approach means essentially whatever one chooses to believe it means. Each person's subjective view, pro or con, is maintained and held by him as the objective view of what math anxiety treatment actually involves. While the picture is not yet complete, the self admitted characteristics of vagueness and anarchism that plague most of these programs make the possibility of their positively contributing to clarifying or achieving goals in mathematics education appear genuinely remote. We anxiously await a well defined research design to prove otherwise.

Programed Learning

After consulting with colleagues it was nearly decided to omit this section for fear of "beating a dead horse." The subsequent decision to include a discussion of programed learning after all is the result of a perception that said "horse" is apparently unwilling to "die and stay dead." A casual review of the educational literature finds that programed materials are abundantly available and commonly used at levels ranging from remedial through a variety of college courses. The continued existence and availability of such materials as a possible alternative to other educational approaches makes a few comments on this subject relevant to our discussion. We begin genetically.

Much of the learning theory from which programmed texts and materials grow traces its roots back to the 19th century writings and experiments of two men; one American, one Russian. Edward Thorndike, the American, is the originator of Connectionism, the stimulus-response-reinforcement learning theory paradigm. This first formulation of the basis of what later became behavioral learning theory appears in the Thorndike classic Animal Intelligence (1898). Pavlov, the Russian, is perhaps even more famous than Thorndike. His conditioned reflex experiments with dogs were performed at about the same time that Thorndike was writing.

According to Kenneth May (1964) the first introduction of programmed materials into teaching in this country began in 1926 with a rather uneventful movement introduced by Sydney L. Pressy. However, the real blitz into education of the programmed approach began in the fifties with B. F. Skinner.⁵ After Skinner, came Norman Crowder and other lesser disciples offering variations of the basic notions of "frames" and branching textbook programs. Whatever the modifications offered by modern programmed materials (e.g., using the computer to direct the student to program branches), virtually all are based on the Thorndike paradigm, or in Skinnerian terminology, on Operant Conditioning. This model sees the learner as a kind of clay to be molded by various educational stimuli. Such a point of view envisions the learner as a rather passive receiver of a great storehouse of ideas or facts. He is to accumulate these facts (in the empirical tradition) until at some propitious moment he has

become knowledgable. Motivation is dealt with on the basis of rewards. The correct answer is rewarded with another, perhaps more difficult, problem. Thus, correct answers somehow stimulate the desire to acquire more correct answers, and perhaps from one point of view, in the hope of ending the drudgery and completing the blasted math course!

Few ideas can be less interesting to a student than the correct answer to what he perceives as an irrelevant question. Where there is no question, how can there be an answer? If the student is not concerned with quadratic equations, of what possible importance can he attach to the roots of such an equation? If it is true that motivation should be the primary concern in our teaching, then programmed materials appear severely restricted in their potential for productive use. An educational strategy that assumes apriori internal student motivation begs the question of how do we motivate our students.

Applications

Applications appear to be the present trend in the mathematics curriculum. While the speaker, like many here, embraces the idea that mathematics is primarily an applied science, we are not optimistic that an applications orientation will in any way alleviate the problem of curriculum purpose that has been described above. It will clarify very little for students, if rather than face a disjoint collection of "how to" techniques, they instead face a similarly disjoint collection of "real life" applications. Incidentally, such is the case

whether the applications are of the relatively genuine variety, or the same old synthetic hash that is now an application because someone, somewhere, decided to call it by that name.⁶ Applications, without programmatic intent, are not different in their impact upon students from other activities when those activities are not consciously directed toward a coherent goal. In short, applications, by themselves, won't provide motivational purpose in an otherwise meaning deficient curriculum.

The Proposal - In General

It is our view that remedial mathematics teaching, more than mathematics teaching at any other level, should concern itself with a conscious demonstration of its purpose to its students. To achieve what we and others have called purposefulness, we propose that courses be organized on the basis of major themes in mathematics. Such a thematic approach, it is hoped, will more vividly demonstrate the purpose of studying mathematics to the learner than most present arrangements.

Dialogue Concerning a Proposal

Q 1: Dear Sir, are you suggesting totally overhauling the present remedial mathematics curriculum?

A 1: No. Rather, I am suggesting the intervention of a point of view (an epistemological step).

Q 2: Whose point of view? Yours?

A 2: As always, the teacher's point of view. The purpose of a thematic approach to teaching remedial mathematics is to make students consciously aware of the value of the subject. We are trying to convince them that there

are significant ideas contained in mathematics that should be part of the knowledge of every adult in our society. However, this does not mean that we need agree on which are those ideas of importance. It is a fair wager that we won't agree.

Q 3: Tell me more. How does this work?

A 3: I'm glad you asked me that...

The Proposal - In Detail

Rather than offer a discussion that is both general and at the same time precise, we present an illustration of our proposal in the specific case of a remedial arithmetic class. Suppose we assume that the following set of topics form the broad outline for the course in question.

Arithmetic 001

1. Whole Numbers - add, subtract, multiply, divide, order of operations, word problems, base 10 structure.
2. Fractions - add, subtract, multiply, divide, order of operations, word problems.
3. Mixed numbers - add, subtract, multiply, divide, order of operations, word problems.
4. Decimals - decimal conversions to fractions and mixed numbers, add, subtract, multiply, divide, extend base 10 structure, rounding off, word problems.
5. Ratio and Proportion - solving proportions, word problems.
6. Percent - percent conversions to decimals, fractions, mixed numbers; word problems.
7. Geometry - perimeter and area of simple closed figures, word problems.
8. Measurement - english and metric units.

The outline above is one version of the ordinary remedial arithmetic course that most of us teach. What follows is a

set of four (4) themes that direct and inform the teaching of just such a course. The themes are chosen from the point of view of the instructor. They reflect his or her perceptions of the subject. They are conscious, consistent and may be expanded, revised or discarded in favor of other themes. They exclude none of the topics above, and in fact, allow for many more at the instructor's discretion. They are:

- I Arithmetic (Mathematics) is a human purposeful creation.
 - (A) Arithmetic is an international cultural achievement.
 - (B) Arithmetic is computationally easier today than ever before.
- II Arithmetic (Mathematics) seeks and utilizes coherent generalizations.
 - (A) Arithmetic rejects vague, specious ideas.
- III Arithmetic (Mathematics) seeks to simplify in order to improve understanding of quantitative phenomena.
- IV Arithmetic (Mathematics) is a powerful, but limited tool.

The above themes give direction both to the overall planning of a remedial arithmetic course and to the specifics of lesson planning as well. We offer a few examples:

- 1. Theme 1 probably independently establishes a rationale for the entire course. However, more specifically, the study of base 10 structure of numerals, systems of measurement and countless word problems can be directly and consistently related to man and his purpose.
- 2. Order of operations may be used to vividly illustrate both the international character of mathematics and the goal of seeking to simplify quantitative expressions.
- 3. A simple excursion into Roman Numerals, Russian Peasant Multiplication (Egyptian Multiplication) or some archaic American and English arithmetic procedures can clearly demonstrate the comparative ease of modern arithmetic methods.

4. Every positive integer is either prime or a product of primes. Such a precise generalization is of great use in arithmetic and is part of the concerns of the subject. In formulating their "own methods" and rules for arithmetic, students will have to develop a similar precision and clarity of thought. For example, it is insufficient to know that in long division one divides and "brings down" numbers. Rather, the students will have to realize at some stage, that in long division, success results only from a noncommutative iterative sequence of steps. It is of course when the students juxtapose those steps that they create those disastrous quotients which have helped grey the hairs of us all.
5. In relation to theme III, what is reducing a fraction if not simplifying? Similarly many operations of arithmetic result in answers which may be interpreted as a more simplified form of the original problem. For example, one divides a complex fraction in order to obtain a simpler and consequently, more understandable simple fraction.
6. Arithmetic has its limits. If the mean number of children per family is 2.2, what does this indicate? If no vehicle travels at a constant rate, what about our calculations? Are they of any value? If both apartments differ rental by only \$1.00 per month, how do we choose? In general, word problems graphically illustrate limitations of mathematics. They also show that mathematical techniques offer a terrific starting point for the analysis and solution to an enormous variety of problems.

SUMMARY

In concluding this presentation let us summarize the highlights. It is our contention that:

1. Students in remediation courses need to be convinced that what they are being asked to learn is of value to their lives; ie.; we need to speak to students' motivation in the actual design of our courses.
2. Most present alternatives for remedial courses weakly recognize motivational questions or ignore them altogether. These alternatives look to gadgetry, spurious vagary or motivation of the lip service variety as the means of dealing with remedial students. Sequence of topics are offered and their interrelations and coherence are supposedly self-evident to students whose actions indicate that in fact, they do not see the point of it all.
3. A thematic approach offers a direction and design into which topics may be fit, ie.; internal coherence is consciously established and topics are explored in relation to the coherence of that point of view. Both change and flexibility are built into thematic teaching. Diversity of opinion and refinement of per-

spective are both encouraged and accomodated.

Finally, let me thank everyone here for your patience and time. Whether you agree or profoundly disagree with our perspective we invite your responses.

NOTES

1. Hector, Judith Ellen. The Effects of Calculator Versus Conventional Algorithms for Fractions on Community College Student Computation, Understanding, and Attitude Sources. (The University of Tennessee, 1978) DAI 39A:6605; May 1979.
2. Koop, Janice Baker. A Description of the Effects of the Use Of Calculators in the Community College Arithmetic Class. (University of Colorado at Boulder, 1978) DAI 39A:4791; February 1979.
3. Rankowski, Charles A. and Glaey, Minaruth. Effectiveness of Multimedia in Teaching Descriptive Geometry. ECTJ 27:114-120; Summer 1979.
4. Tobias, Sheila. "Overcoming Math Anxiety", - a speech before a workshop of the American Mathematics Association of Two Year College's Annual Meeting; Sunday, October 12, 1980, Washington D.C.
5. May, Kenneth O. Programmed learning and Mathematics Education. Mathematical Association of America (National Science Foundation, 1964) p.1.
6. In this connection see S.I.A.M. News, Vol. 13, No. 8, October, 1980; in which the editor discusses the apparent drift toward overtly fabricated word problems. The Commentary column entitled "Applications and Tail Fins" is brief, but pointed.

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